

The seabirds of the Conrad Rise, Southern Ocean

Peter G. Ryan

Les oiseaux de mer du Conrad Rise, Océan austral. À l'occasion d'un inventaire océanographique du Conrad Rise (51–55°S et 39–47°E) en avril 2008, les oiseaux de mer ont été recensés. Le Conrad Rise est une vaste zone relativement peu profonde où le fond sous-marin s'élève à <3.000 m, située juste au sud du Front polaire antarctique et 550–700 km au sud des Îles du Prince Edouard et Crozet. Au moins 28 espèces ont été observées, parmi lesquelles les puffinures *Pelecanoides* spp., le Prion bleu *Halobaena caerulea* et le Pétrel de Kerguelen *Lugensa (Aphodroma) brevirostris* étaient les plus abondants, tandis que le Manchot royal *Aptenodytes patagonicus* et le Gorfou doré *Eudyptes chrysolophus* représentaient la biomasse la plus importante. Le Pétrel bleu et le Puffin à menton blanc *Procellaria aequinoctialis* étaient les plus abondants pendant que le navire était immobile, malgré le fait que l'Albatros hurleur *Diomedea exulans* et le Pétrel de Hall *Macronectes halli* étaient les espèces les plus attirées par le navire. La plupart des espèces étaient plus abondantes au nord de la zone prospectée, mais le Puffin fuligineux *Puffinus griseus* a uniquement été recensé au sud de 56°30'S. Des photos numériques ont permis de confirmer l'identification des groupes d'espèces difficiles à distinguer en mer, surtout les prions. Le Prion de Belcher *Pachyptila belcheri* et le Prion colombe *P. turtur* étaient les prions les plus abondants, tandis que le Prion de la Désolation *P. desolata* a été observé en petit nombre, et le Prion de Salvin *P. salvini* pas du tout. Relativement peu de mammifères marins ont été observés; le Rorqual commun *Balaenoptera physalus* était toutefois commun au sud de 56°S. Le résultat des transects n'indique pas une abondance avienne plus importante dans les eaux peu profondes (<250 m). La fréquentation du navire par les oiseaux était toutefois la plus grande sur le Banc O'b, ce qui est peut-être indicatif d'activités de pêche récentes. La périphérie du Conrad Rise semble être une importante zone de nourrissage pour les puffinures et les manchots à cette époque de l'année.

Summary. Seabirds were counted during an oceanographic survey of the Conrad Rise (51–55°S and 39–47°E) in April 2008. The Conrad Rise is a large area of shallower water where the seafloor rises to < 3,000 m deep, lying just south of the Antarctic Polar Front and 550–700 km south of the Prince Edward and Crozet archipelagos. At least 28 species were observed, with diving petrels *Pelecanoides* spp., and Blue *Halobaena caerulea* and Kerguelen Petrels *Lugensa (Aphodroma) brevirostris* most abundant, but King *Aptenodytes patagonicus* and Macaroni Penguins *Eudyptes chrysolophus* dominating in terms of biomass. Blue Petrels and White-chinned Petrels *Procellaria aequinoctialis* were most abundant while the ship was stationary, although Wandering Albatrosses *Diomedea exulans* and Northern Giant Petrels *Macronectes halli* were most strongly attracted to the ship. Most species were more abundant in the north of the survey area, but Sooty Shearwaters *Puffinus griseus* were only recorded south of 56°30'S. Digital photography was useful to confirm the identification of species groups that are tricky to discriminate at sea, especially prions. Slender-billed Prion *Pachyptila belcheri* and Fairy Prion *P. turtur* were the most abundant prions, with only small numbers of Antarctic Prions *P. desolata*, and no Salvin's Prions *P. salvini*. Relatively few marine mammals were observed, but Fin Whales *Balaenoptera physalus* were common south of 56°S. Transects provided no evidence of increased bird abundance at shallow (<250 m) seamounts, but ship attendance peaked on the O'b Bank, possibly reflecting recent fishing activities. The periphery of the Conrad Rise appears to be an important foraging area for diving petrels and penguins at this time of year.

The Conrad Rise is a large area of shallower water in the Southern Ocean between 51–55°S and 39–47°E, where the seafloor rises

from the abyssal plain >4,000 m deep to < 3,000 m deep (Fig. 1). This change in bottom topography apparently influences local oceanic circulation

patterns, resulting in eastward jets north and south of the rise. The Conrad Rise lies just south of the Antarctic Polar Front, *c.*550 km south-southeast of the Prince Edward Islands and 700 km southwest of the Crozet Islands. Both archipelagos are breeding sites for globally important seabird populations, notably large numbers of penguins, albatrosses and petrels (Williams 1995, Brooke 2004, Ryan & Bester 2008). The Conrad Rise lies in an area used extensively by King Penguins *Aptenodytes patagonicus* from the Crozets (Pütz *et al.* 1999, Charrassin & Bost 2001), and a Macaroni Penguin *Eudyptes chrysolophus* tracked during its pre-moult fattening trip travelled 700 km south of the islands into the general vicinity of the rise (Hockey *et al.* 2005).

The Conrad Rise includes two seamounts, O'b Bank and Lena Seamount, which extend to within 250 m of the surface. Another, unnamed seamount lies just east of the Rise (Fig. 1). These seamounts have been fished for Patagonian toothfish *Dissostichus eleginoides*, but there are no published observations on the region's birds. Albatrosses and petrels at risk from long-line fishing have been tracked into the general area south of the Prince Edwards and Crozets (BirdLife International 2004). I accompanied an oceanographic survey of the region in April 2008 to record the distribution and abundance of seabirds associated with the Conrad Rise. The survey included the surrounding seas between 48–57°S and 38–48°E (Fig. 1), and took place in autumn, when sea-ice conditions were minimal around Antarctica. A satellite ice image for 4 April 2008 indicated no sea-ice north of 64°S in the sector of the Southern Ocean between 30–60° E.

Methods

Seabirds were counted during the day (roughly 06.30–17.30 hrs local time) on standard steaming transects (Tasker *et al.* 1984) as well as at oceanographic stations. Transects were conducted from the ship's bridge (9 m above sea level), looking beyond the bow on that side of the ship offering best visibility. Flying birds were counted, using binoculars, every minute by scanning a 300 m-block extending forward from the bow. Ship followers that repeatedly circled the ship were excluded. More frequent scans were made of the same area for birds on the water, such as penguins and diving petrels, which are easily overlooked,

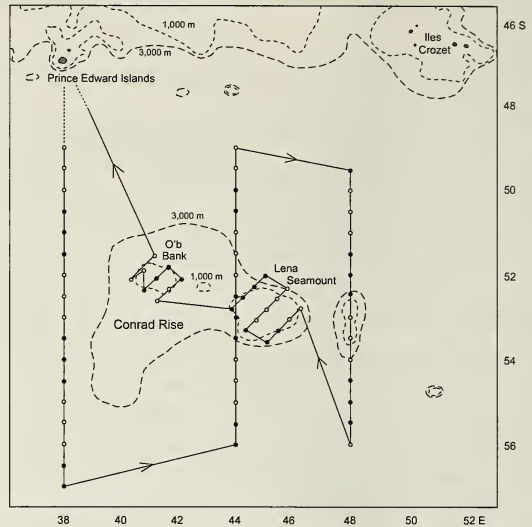


Figure 1. The study area in relation to the Prince Edward and Crozet islands and regional bathymetry, showing the cruise track, with arrows indicating the direction of travel. Circles along the cruise track are CTD stations (open = daylight, closed = night).

La zone d'étude par rapport aux Îles du Prince Edouard et Crozet et la bathymétrie régionale, avec le trajet du navire, les flèches indiquant la direction du navire. Les cercles le long du trajet du navire sont des stations CTD (conductivité, température, profondeur) (ouvert = de jour, fermé = de nuit).

especially when the sea is rough. All birds were recorded to the nearest minute, but were pooled into 30-minute minimum count blocks. Identification of tricky groups was confirmed, where possible, by photographing birds with a digital SLR and 500-mm telephoto lens.

The oceanographic survey departed Marion Island on 3 April, and commenced sampling at 49°S 38°E on 4 April. Initially a widely spaced grid was run with north–south legs at 38°E, 44°E and 48°E (Fig. 1). On these legs, CTD (conductivity, temperature, depth) stations were conducted every 30 nautical miles. This required the ship to stop on station for *c.*70–90 minutes while the CTD was lowered to 2,000 m. Stations were shorter where the water was shallower. Between stations, the ship steamed at 9–12 knots (16.5–22 km.h⁻¹), permitting 2.0–2.5 hours of transect counts. Counts did not commence until the ship had attained full speed and had left the last station by at least 2 km. On average, 5.3 hours of transects were conducted daily (3.5–7.5), all

made by the same observer. Crude estimates of seabird density (numbers.km⁻²) were made assuming the transect counts accurately reflected the abundance of flying birds in the 300-m wide count area. Apart from 18 April, when seas were exceptionally calm, no penguin groups were observed >200 m from the ship (80% ≤100 m, *n*=96 groups), and so a conservative estimate of 200-m wide effective transect width was assumed for all days except 18 April (300 m).

At each CTD station, counts of birds attending the ship (within *c.*500 m) were made for ten minutes shortly after arrival at the station, and again after 30 and 60 minutes. Dumping of galley waste (the only material dumped at sea) was only conducted after dark each evening and thus should not have overly influenced the behaviour of birds to the ship. After testing for consistent patterns in numbers of birds attending as a function of time on station, a single count for each station was taken to be the maximum number of each species seen during the three counts. Only one or two counts were made at stations conducted at dawn or dusk and at some shallow-water sites. Typically three stations were conducted daily, but on some days there were longer steams between stations (transits from 38–44°E, 44–48°E, 48°E to Lena Seamount, between Lena Seamount and O'b Bank, and from O'b Bank en route to Marion Island). Stern counts of birds following the ship were made during these legs and used in lieu of station counts to bring the sample size for each day to three counts. The ratio of birds attending the ship to those counted during transects was used to provide a crude index of ship attraction.

The course grid concluded at 56°S 48°E on 13 April. The ship then travelled to Lena Seamount, where 13 CTD stations were conducted 20 nautical miles apart and to O'b Bank, where nine stations were conducted 15 nautical miles apart (Fig. 1). This permitted 1.0–1.5 hours of transect observations between stations. Finally, the ship returned to Marion Island, arriving early on 19 April. Steaming transects were conducted until 48°S. During the survey we visited one iceberg at 55°36'S 47°21'E on 13 April. The only other ice encountered was three distant icebergs (>20 km off the cruise track) between 54°45'S and 55°20'S at 38°00'E on 6 April. No other shipping was encountered during the survey.

Results and Discussion

At least 28 seabird species were recorded, 24 during 80 hours of steaming transects and 25 at 35 oceanographic stations or during ten stern counts (Table 1). The most abundant birds during transects were diving petrels *Peleconoides* spp., Blue Petrels *Halobaena caerulea*, Kerguelen Petrels *Lugensa (Aphodroma) brevirostris* and crested penguins *Eudyptes* spp., whereas on stations Blue Petrels and White-chinned Petrels *Procellaria aequinoctialis* predominated (Table 1). Most albatrosses and petrels exhibited a high index of ship attraction (Table 1), with Northern Giant Petrels *Macronectes halli* and Wandering Albatrosses *Diomedea exulans* highest, followed by White-chinned Petrels, sooty albatrosses *Phoebastria* spp., Southern Giant Petrels *Macronectes giganteus*, Pintado Petrels *Daption capense* and Grey Petrels *Procellaria cinerea*. Only specialist diving species (diving petrels, penguins and shearwaters) were encountered much more frequently during transects than attending the ship (Table 1).

Species richness decreased with increasing latitude due to several species failing to penetrate south of 52°S (e.g. Soft-plumaged Petrel *Pterodroma mollis*, Little Shearwater *Puffinus assimilis*). Other species occurred further south, but were more abundant in the north (e.g. Sooty Albatross *Phoebastria fusca*, Great-winged Petrel *Pterodroma macroptera*, Grey Petrel). Sooty Shearwater *Puffinus griseus* was the only species that was recorded in the south of the survey area but was absent further north. The following sections report the distribution and abundance patterns of the species encountered.

Penguins

Given the general paucity of sightings at sea away from colonies in the Southern Ocean (Enticott 1986, Marchant & Higgins 1990), a large number of penguins was counted. However, some groups doubtless were overlooked, especially in rough seas, so the number counted represents a minimum estimate of penguin abundance. Most observations were of crested penguins. Both Macaroni and Southern Rockhopper Penguins *Eudyptes chrysocome* may occur in the region, but all crested penguins positively identified were Macaroni Penguins. Only four of 70 groups were thought to be possible Rockhoppers (one at 49°05'S 37°59'E, two at 49°15'S 44°00'E and one

Table 1. Numbers of birds counted during steaming transects (80 hours) and attending the ship (maximum counts at 35 stations and ten stern counts while steaming). Frequency of occurrence reports the percentage of 30-minute transect counts ($n=160$) and ship counts ($n=45$) for which a species was present.

Tableau 1. Nombre d'oiseaux de mer recensés en parcourant les transects (80 heures) et fréquentant le navire (totaux maximaux sur 35 stations et dix comptages à partir de la poupe en navigant). La fréquence de présence indique le pourcentage des comptages de transects de 30 minutes ($n=160$) et des comptages autour du navire ($n=45$) pendant lesquelles l'espèce était présente.

Species	Transects		Stations		Total	Ship attraction*
	<i>n</i>	% freq.	<i>n</i>	% freq.		
Emperor Penguin <i>Aptenodytes forsteri</i>	0	0	1	2	1	
King Penguin <i>Aptenodytes patagonicus</i>	132	16	3	4	135	—
Adélie Penguin <i>Pygoscelis adeliae</i>	1	1	0	0	1	
Crested penguins <i>Eudyptes</i> spp.	232	29	33	11	265	—
Wandering Albatross <i>Diomedea exulans</i>	6	4	89	80	95	+++
Grey-headed Albatross <i>Thalassarche chrysostoma</i>	14	9	44	69	58	+
Sooty Albatross <i>Phoebastria fusca</i>	4	3	13	29	17	++
Light-mantled Sooty Albatross <i>Phoebastria palpebrata</i>	16	11	36	56	52	+
Southern Giant Petrel <i>Macronectes giganteus</i>	5	3	37	53	42	++
Northern Giant Petrel <i>Macronectes halli</i>	4	2	109	71	113	+++
Southern Fulmar <i>Fulmarus glacialisoides</i>	0	0	3	7	3	
Pintado Petrel <i>Daption capense</i>	2	1	22	36	24	+++
Blue Petrel <i>Halobaena caerulea</i>	286	84	478	100	764	
Antarctic Prion <i>Pachyptila desolata</i>	17	8	12	20	29	
Slender-billed Prion <i>Pachyptila belcheri</i>	65	29	112	71	177	
Fairy Prion <i>Pachyptila turtur</i>	48	23	71	67	119	
Kerguelen Petrel <i>Lugensa (Aphrodroma) brevirostris</i>	174	71	84	84	258	
Soft-plumaged Petrel <i>Pterodroma mollis</i>	9	5	3	7	12	—
White-headed Petrel <i>Pterodroma lessonii</i>	18	11	11	24	29	
Great-winged Petrel <i>Pterodroma macroptera</i>	12	8	11	22	23	
White-chinned Petrel <i>Procellaria aequinoctialis</i>	33	20	263	98	296	++
Grey Petrel <i>Procellaria cinerea</i>	5	3	12	24	17	+
Sooty Shearwater <i>Puffinus griseus</i>	96	3	2	2	98	—
Little Shearwater <i>Puffinus assimilis</i>	2	1	0	0	2	
Diving petrels <i>Pelecanoides</i> spp.	378	66	10	22	388	—
Wilson's Storm Petrel <i>Oceanites oceanicus</i>	1	1	0	0	1	
Black-bellied Storm Petrel <i>Fregatta tropica</i>	34	17	28	42	62	
Subantarctic Skua <i>Catharacta antarctica</i>	+	0	0	0	+	
Arctic Tern <i>Sterna paradisaea</i>	0	0	1	2	1	
Total	1,593		1,487		3,082	

* ratio of transect to ship counts; + indicates more often at the ship, — more often on transects. Number of symbols denotes strength of difference: +++/—>tenfold, ++/— 5–10 fold, +/—2–5 fold difference (no symbol implies either the sample size is too small, or difference <twofold).

at 49°06'S 44°50'E), but none was photographed to confirm identification. All groups photographed ($n=23$) were correctly identified as Macaroni Penguins (broad crest and large pink gape). They were observed south to 53°21'S, with peak densities at 50–52°S (Fig. 2). The density between 48–49°S is perhaps biased because the transects were relatively close to Marion Island. Group size during transects was 3.5 ± 3.6 ($n=65$ groups, mode 2, range 1–20), and all photographed birds were adults (based on well-developed crests). Macaroni Penguins also were observed at five stations, where group sizes averaged slightly larger (6.6 ± 4.5 , range 2–14,

$n=5$). The few at-sea sightings of Macaroni Penguins suggest they move south of the breeding islands in the south-west Indian Ocean (Marchant & Higgins 1990). Macaroni Penguins from Marion Island in the Prince Edwards have been tracked to 700 km south of the island during their pre-moult fattening trip (Hockey *et al.* 2005; R. J. M. Crawford pers. comm.).

King Penguins generally were easier to spot at sea than crested penguins, especially among large waves, because they usually extended their long necks to peer at the vessel. Unlike crested penguins, they seldom porpoised away from the ship. However, they were less often seen at stations,

despite being more curious of ships than crested penguins close to the Prince Edward Islands (pers. obs.). King Penguins were most common between 51°30'S and 54°S, although small numbers were seen further north (Fig. 2). Like diving petrels, there was a tendency for a lower density over the shallows of the Conrad Rise compared to the periphery. Group size during transects 4.3 ± 3.6 ($n=31$ groups, mode 2, range 1–18) was greater than that of groups visiting the ship on station (1.5 ± 0.7 , range 1–2, $n=2$). All but one (a lone immature at 53°S 38°E on 5 April) were adults with bright orange neck patches. King Penguins from the Crozet Islands forage south of 45°S irrespective of season, travelling 500–750 km from colonies in summer and up to 1,800 km during winter, including into the pack-ice to 62°S (Pütz *et al.* 1999, Charrassin & Bost 2001).

A single immature Emperor Penguin *Aptenodytes forsteri* visited the ship while on station at 53°S 38°E on 5 April. It was next to a group of Macaroni Penguins, and there were King Penguins at the same station. It was readily identified by its large size, relatively short neck and bill, diffuse white neck patch, and humped back that protrudes much further above the surface than that of a King Penguin. The only penguin observed south of 54°S was tentatively identified as an adult Adélie Penguin *Pygoscelis adeliae* based on its all-dark head and throat, and short bill. However, light conditions were poor, and there is a chance it was a crested penguin (albeit well south of all other records). Both Emperor and Adélie Penguins typically remain further south, but vagrants reach the subantarctic (Marchant & Higgins 1990).

Albatrosses

Only four species of albatross were observed, although two others (Black-browed *Thalassarche melanophris* and Shy *T. cauta*) followed the ship at 46°59'S 38°10'E south-east of Marion Island on 3 April. Wandering Albatross was the most abundant albatross overall, with most at stations (Table 1). The largest aggregation was observed on O'b Bank on 17 April, when up to 11 gathered at the ship. With the exception of a stage 2 ('leopard stage') bird observed at 49°S 44°E, all were in adult plumage (Gibson stages 5–8), and south of 53°S most were 'terminal stage', presumably adult males. The youngster (an apparent female based on bill size and shape) landed with three adults,

resulting in display and calling. The predominance of adult males further south corroborates previous observations and tracking data in the southern Indian Ocean (Weimerskirch & Jouventin 1987, Weimerskirch 1998). However, it is unlikely that many breeding birds were in the area, as the survey took place during the brood/guard phase, when foraging trips tend to be localised around the breeding islands (Weimerskirch 1998, Nel *et al.* 2002). Based on limited tracking data, it is more likely the birds encountered came from the Crozets rather than the Prince Edwards or Kerguelen (BirdLife International 2004).

Grey-headed Albatross *Thalassarche chrysotoma* was the next most abundant albatross and again adults predominated, with only four immatures (7%) seen. However, at least one apparent adult that was photographed still had a dark nail, indicating it was a subadult, perhaps 3–4 years old. Three of the immatures were seen north of 52°S (11% of birds in this area), with the other immature at 56°15'S 42°25'E (4% of birds south of 52°S). Latitudinal segregation of adults and immatures has not been reported in this species (Tickell 2000), although almost all records north of 40°S are immatures (Hockey *et al.* 2005).

Light-mantled Sooty Albatross *Phoebastria palpebrata* was the albatross least strongly attracted to the ship, although they were still more abundant in station counts than during transects. A higher proportion of this species (37%) was in mottled immature plumage and, unlike the other albatross species, immatures tended to be more common further south (21% north of 52°S, 29% between 52–54°S and 60% south of 54°S). Sooty Albatross was relatively scarce. All were adults and were only counted north of 53°S, but an adult visited the ship briefly at 55°50'S 38°00'E on 6 April. Sooty Albatrosses breeding at both Marion Island and the Crozets remain north of the Antarctic Polar Front at around 50°S (Berruti 1979, Cooper & Klages 1995, Weimerskirch 1998), whereas Light-mantled Sooty Albatrosses forage south of the Front (R. J. M. Crawford unpubl.). However, Jouventin *et al.* (1981) reported both species to be common south to 56°S in the south Indian Ocean, and they occasionally eat Antarctic krill *Euphausia superba*, which must be caught south of the Front (Ridoux 1994).

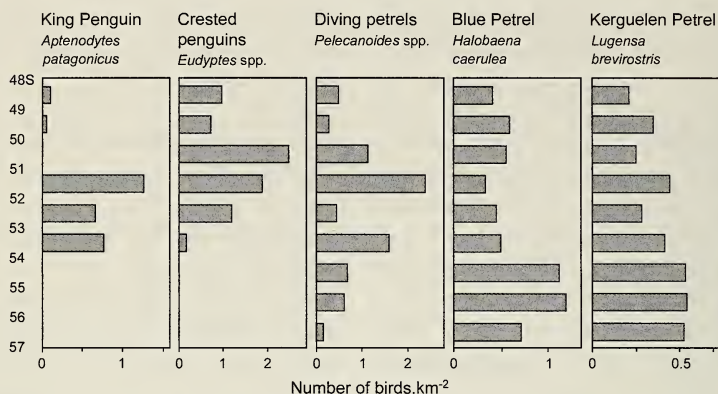


Figure 2. Average density of the most abundant seabirds counted in steaming transects as a function of latitude. Densité moyenne des oiseaux de mer les plus abondants recensés en parcourant les transects en fonction de la latitude.

Fulmarine petrels

Giant petrels occurred throughout the survey area, with Northern outnumbering Southern. No white-morph Southern Giant Petrels were observed. Both species were attracted to the ship, following while it was travelling and either circling or resting on the water next to the ship on station. The largest numbers of giant petrels were observed on O'b Bank on 17 April, when up to 27 (24 Northern and three Southern) gathered at the ship while on station. The greater aggregation of ship-attendant species on O'b Bank may possibly reflect recent fishing activities.

Other fulmarine petrels were surprisingly scarce, with only small numbers of Pintado Petrels and Southern Fulmars *Fulmarus glacialisoides* seen. It was presumably just too early for these species to have dispersed north from their breeding areas (Marchant & Higgins 1990). There was no sign of the ice-specialist Snow *Pagodroma nivea* or Antarctic Petrels *Thalassoica antarctica*.

Blue Petrels and prions *Pachyptila*

Blue Petrels occurred throughout the survey area, with a tendency for higher densities at 54–56°S (Fig. 2), supported by larger mean numbers attending the ship at these latitudes. It was the most abundant species at stations, occurring at every station (Table 1), and, although second to diving petrels in terms of abundance during transects, had the highest frequency of occurrence in half-hour transect blocks (86%). Accurate transect counts were complicated by the habit of petrels accompanying the ship to fly ahead of it. It was possible to ignore such birds if they turned within

a few hundred metres of the bow, but some undoubtedly returned after flying further ahead and may have been counted in error. Although most were adults, some fresh-plumaged juveniles were photographed, distinguished by their more prominent pale feather fringes and paler crown and breast-band. Breeding Blue Petrels forage over a wide latitudinal range, often travelling into Antarctic waters >1,000 km from the breeding islands (Cherel *et al.* 2002). Stable isotope analysis of adult feathers suggests that they remain in these waters during the moulting period.

Reliable information on the distribution and relative abundance of prions at sea is limited by the difficulty of positively identifying them to species (Marchant & Higgins 1990). The use of digital photography was essential in this regard. On several occasions the presence of a species was only confirmed by examining photographs taken at a station. Three species of prions were observed in the area: Antarctic Prion *Pachyptila desolata*, Fairy Prion *P. turtur* and Slender-billed Prion *P. belcheri*. Fairy and Slender-billed Prions were most abundant and occurred throughout the survey area, although Fairy Prions were more abundant in the north, whereas Slender-billed Prions were more common further south, mainly south of the Antarctic Polar Front, with the greatest numbers at 54–56°S. The Slender-billed Prions presumably come from the large Kerguelen breeding population (Brooke 2004).

Antarctic Prions were relatively scarce and were only recorded south of 50°S. However, Antarctic Prions also were fairly common at 39–40°S on 28 March, en route between Cape

Town and Marion Island. Interestingly, most of these more northerly prions were moulting their primaries, whereas none of the birds south of Marion was replacing the flight feathers. Only one prion amongst hundreds photographed in the survey area was moulting its primaries: a Slender-billed Prion completing its primary moult on 10 April at 49°S 44°E.

No Salvin's Prions *P. salvini* were observed, either off Marion Island or further south, despite that a large population breeds at the Prince Edward and Crozet archipelagos (Marchant & Higgins 1990). Small numbers were photographed north of Marion Island (39–44°S) en route between the island and Cape Town in late March and the end of April, supporting their preference for warmer waters (Marchant & Higgins 1990).

Gadfly petrels

Kerguelen Petrel was the third commonest bird during transects, occurring throughout the region (Fig. 2). Although regularly attracted to the ship on station, they were more abundant in transect counts. On station, they tended to hang off the stern, fluttering high in the sky, or circle the ship a few times then depart. White-headed Petrels *Pterodroma lessonii* were the most abundant *Pterodroma*, also occurring throughout the area, but were relatively scarce. The other two gadfly petrels, Great-winged and Soft-plumaged Petrels, were both uncommon, with Soft-plumaged Petrels only recorded north of 52°S and all but two Great-winged Petrels north of 52°30'S (furthest south at 55°35'S 38°00'E).

Procellaria petrels and shearwaters

White-chinned Petrel was the second most abundant species at stations, occurring at all but one station. Relatively few were counted during transects but, like Blue Petrels, transect counts were complicated by White-chinned Petrels circling the ship, and often 'running' well ahead of the ship. Their numbers typically increased during the first hour of daylight, then remained relatively constant all day, suggesting the same individuals remained with the ship throughout the day. White-chinned Petrels have a very broad foraging range, from Antarctic to temperate waters (Weimerskirch *et al.* 1999). Grey Petrels were much less common than White-chinned Petrels, and although most were recorded on stations, they were less assiduous ship-

followers, seldom remaining at the vessel for more than a minute or two. All were north of 53°30'S.

Shearwaters generally were uncommon in the area. Sooty Shearwaters were only seen on the morning of 7 April, when numerous flocks of up to 50 were seen from dawn until 10.00 hrs. All were south of 56°30'S and travelling south-east. This was the only day of the survey spent south of 56°S. Little Shearwaters were rare, with two observed during transects at 50°30'–51°30'S. Neither species evinced any interest in the ship.

Diving petrels

Diving petrels were the most abundant species recorded during transect counts (Table 1). Both Common *Pelecanoides urinatrix* and South Georgian Diving Petrels *P. georgicus* can be expected to occur in the region, although Common Diving Petrels apparently tend to remain closer to their breeding islands, at least during the breeding season, than do South Georgian Diving Petrels (Marchant & Higgins 1990, Bocher *et al.* 2000). Even when photographed, the criteria to separate the two species in the field are not definitive (Shirihai 2007). The eight diving petrels photographed sufficiently well to identify appeared to be South Georgian (based on clean, black and white plumage, relatively broad white trailing edge to secondaries, and the presence of a pale 'C' around the ear-coverts). My impression is that most birds were this species, but some rather plain birds with dark heads and breasts may have been Common Diving Petrels. Based on stable-isotope signatures in feathers from adults, both species apparently forage on the same prey in offshore waters while moulting (Bocher *et al.* 2000).

Diving petrels occurred throughout the study area, but were most abundant at 51–52°S and 53–54°S, on the periphery of the Conrad Rise (Fig. 2). The highest abundance occurred south-east of Lena Seamount, where there were 10 petrels.km⁻². I have not seen anything like these densities away from breeding colonies previously. The area around the Conrad Rise appears to be a key foraging area, at least at this time of year.

Storm petrels

Although Grey-backed Storm Petrel *Oceanites nereis* was observed close to Marion Island on 3 April, only two species of storm petrel were seen during the survey. Black-bellied Storm Petrel

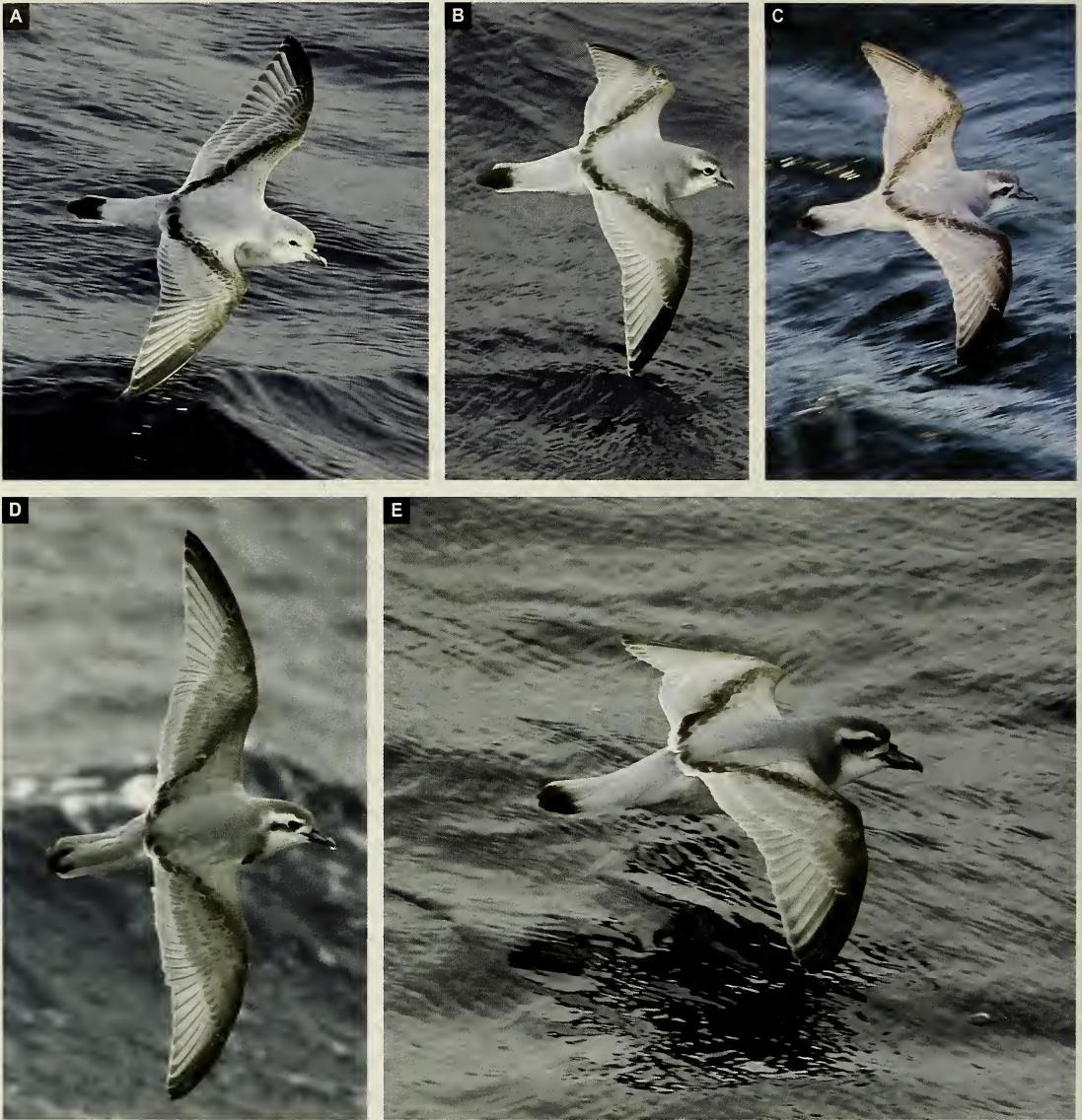


Figure 3. Prions are notoriously difficult to identify at sea. Photographing birds helps greatly, although not all individuals can be identified with certainty, especially between Slender-billed *Pachyptila belcheri*, Antarctic *P. desolata* and Salvin's Prions *P. salvini* (which was not recorded during the survey). The images here show typical birds: (E) Salvin's Prion (note large head, deep-based bill and steep forehead), (C) Antarctic Prion (smaller bill and more rounded forehead), (D) Slender-billed Prion (narrow bill, rather pale head with a prominent supercilium broadening behind the eye and narrow black tail tip) and (A & B) Fairy Prion *P. turtur* (short, stubby bill and more extensive black tail tip). Most Fairy Prions show rather plain faces, but some have stronger facial markings (Peter Ryan)

Il est notoire que les prions sont difficiles à identifier en mer. Même si photographier les oiseaux rend la tâche beaucoup plus facile, il ne faut pas s'attendre à pouvoir identifier tous les individus avec certitude, surtout quand il s'agit d'espèces comme le Prion de Belcher *Pachyptila belcheri*, le Prion de la Désolation *P. desolata* ou le Prion de Salvin *P. salvini* (qui n'a pas été noté pendant le recensement). Les photos présentées ici montrent des oiseaux typiques : (E) le Prion de Salvin (noter la tête et le bec forts et le front abrupt), (C) le Prion de la Désolation (bec plus petit, front plus bombé), (D) le Prion de Belcher (bec mince, tête plutôt pâle avec un sourcil très marqué s'élargissant derrière l'œil, queue avec étroite barre terminale noire) et (A & B) le Prion colombe *P. turtur* (bec court et tronqué, queue avec barre terminale noire plus large). La plupart des Prions colombes ont les côtés de la tête plutôt unis, mais certains individus présentent des marques faciales contrastées (Peter Ryan)

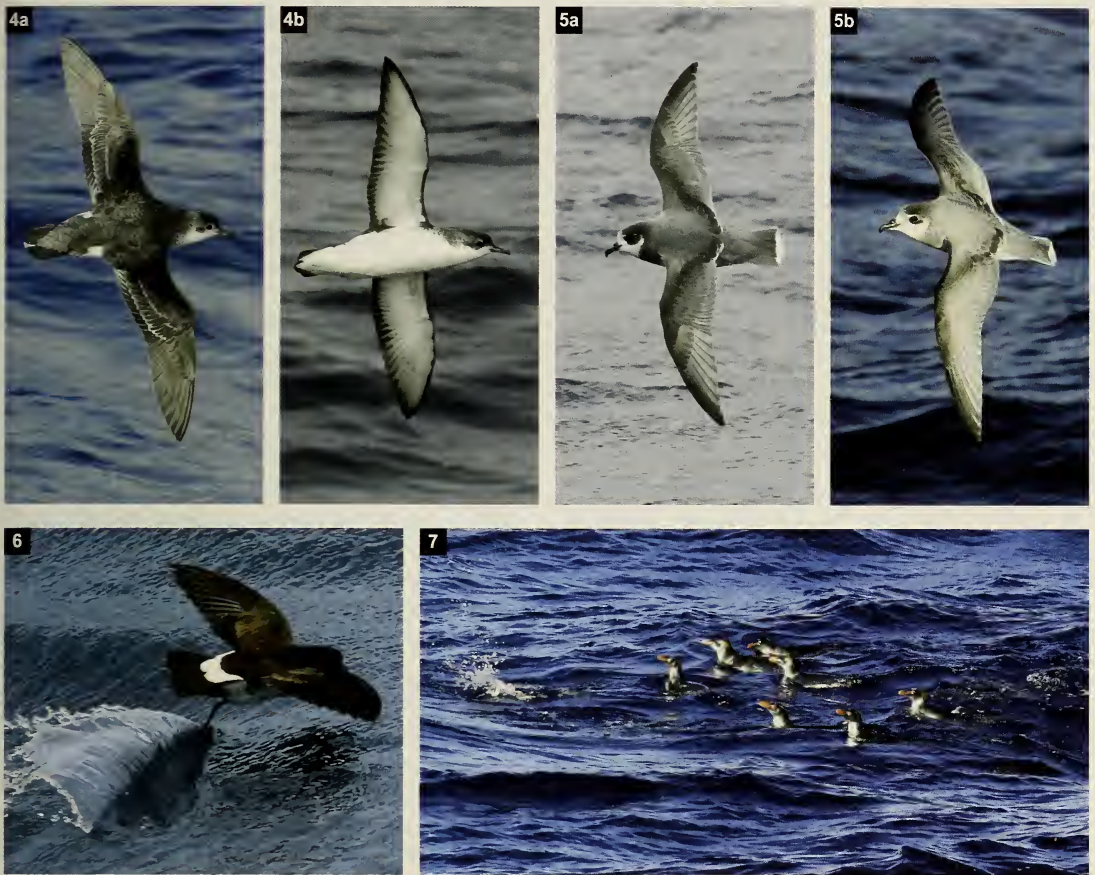


Figure 4. The Little Shearwaters *Puffinus assimilis* encountered were of the subantarctic form *elegans*, which is treated as a distinct species by some authorities (Peter Ryan)

Les Petits Puffins *Puffinus assimilis* observés étaient de la forme subantarctique *elegans*, qui est traitée comme une espèce distincte par certains auteurs (Peter Ryan)

Figure 5. Blue Petrels *Halobaena caerulea* are not usually regarded as having a distinct juvenile plumage, but in addition to having pale fringes to their upperpart feathers, fresh-plumaged juveniles (b) typically have paler and less extensive dark feathering on the crown, face and breast than adults (a) (Peter Ryan)

D'habitude le Prion bleu *Halobaena caerulea* n'est pas supposé avoir un plumage juvénile distinct, mais en plus des liserés pâles aux plumes des parties supérieures, les juvéniles en plumage frais (a) diffèrent typiquement des adultes (b) en ayant la calotte, les côtés de la tête et la poitrine plus pâles (Peter Ryan)

Figure 6. Black-bellied Storm Petrels *Fregatta tropica* were the most abundant storm petrels in the area, but became scarce south of 50°S. They frequently 'water-ski' across the surface on one foot, making a distinctive 'rooster-tail' splash (Peter Ryan)

L'Océanite à ventre noir *Fregatta tropica* était l'océanite le plus abondant dans la zone, mais il devenait plus rare au sud de 50°S. Il 'glisse' fréquemment sur un pied à la surface de l'eau, produisant un éclaboussement caractéristique (Peter Ryan)

Figure 7. One of the many groups of Macaroni Penguins *Eudyptes chrysolophus* observed around the Conrad Rise (Peter Ryan)

Un des nombreux groupes de Gorfous dorés *Eudyptes chrysolophus* observés autour du Conrad Rise (Peter Ryan)

Fregatta tropica occurred throughout, but was six times more abundant north of 50°S (averaging 0.18 km⁻² compared with 0.03 km⁻² south of 50°S in transect counts). Comparable data for station counts were 2.1 and 0.3 birds per station north and south of 50°S. One Wilson's Storm Petrel *Oceanites oceanicus* was observed at 50°S 38°E on 4 April.

Other birds and marine mammals

Only two non-procellariiform seabirds were observed: a Subantarctic Skua *Catharacta antarctica* at 56°35'S 40°20'E on 7 April, and an immature Arctic Tern *Sterna paradisaea* visited the ship on station, at 52°43'S 45°39'E, on Lena Seamount on 15 April. A Cattle Egret *Bubulcus ibis* briefly landed on the ship while on station at 50°S 48°E on 11 April. It was quite weak, and had trouble perching. It was blown off the ship after a few minutes and presumably perished.

Relatively few marine mammals were observed. Fin Whales *Balaenoptera physalus* were common on 7 April between 56°35'S 40°20'E and 56°14'S 42°10'E, with an estimated 30 animals seen in eight groups (positively identified as Fin Whales in three groups). Several groups comprised whales that apparently were feeding, surging to the surface, and lying on their sides, thrashing their tail flukes out of the water. No birds were closely associated with any of these whales. Another Fin Whale was photographed at 48°48'S 39°10'E on 18 April, with another two whales blowing further away. A single large baleen whale (possibly a Fin Whale) approached the ship on station at 51°S 44°E on 9 April. Only three other cetaceans were observed: an unidentified, 3–4-m dolphin showed briefly near 56°41'S 39°52'E on 7 April, a probable beaked whale breached several times near 50°42'S 48°00'E on 11 April, and a suspected Sperm Whale *Physeter macrocephalus* was blowing at 51°55'S 41°12'E on 17 April. No seals were seen, which is perhaps not too surprising given that seals from the Prince Edward Islands typically forage south-west of the islands along the Southwest Indian Ridge (Ryan & Bester 2008).

Conclusions

Species richness in these peri-Antarctic waters is relatively low. With the exception of the Emperor Penguin and possible Adélie Penguin, no truly Antarctic species were observed, presumably due

to the absence of sea-ice. The only birds associated with the sole iceberg encountered on the survey were a mixed flock of 15–20 Blue Petrels and prions flying close below the cliffs of the iceberg. There was no sign of Chinstrap Penguins *Pygoscelis antarctica*, which are common in spring around 55°S (pers. obs.). The low diversity also results from the failure of many subantarctic species to penetrate southwards much beyond the Antarctic Polar Front.

The cumulative abundance of Blue and Kerguelen Petrels and Slender-billed Prions, especially from 54–56°S, is intriguing given the irruption of all three species into temperate waters off South Africa, Australia and eastern South America in the austral winter of 1984 (Ryan *et al.* 1989). It suggests that something peculiar happened at these latitudes that year causing large numbers of birds of all three species to move well north of their usual range. Blue Petrels breeding at Kerguelen experience periodic population crashes linked to increased winter mortality in anomalously warm years (Barbraud & Weimerskirch 2003). Unfortunately, records do not extend to the early 1980s, but this epoch corresponds with the end of a sustained period of unusually warm years in the Antarctic that resulted in an apparent shift in the functioning of pelagic ecosystems in the Southern Ocean (Jenouvrier *et al.* 2005).

Perhaps the most interesting finding of the study was the large numbers of diving petrels and penguins encountered. Diving petrels were the most abundant bird encountered during steaming transects, and penguins comprised some 80% of the avian biomass on transects. Clearly the periphery of the Conrad Rise is an important foraging area for diving petrels and penguins, at least at this season. Although there was no evidence of increased bird abundance in transects on the seamounts, ship attendance peaked on O'b Bank, and is possibly a consequence of past fishing activity on the seamounts.

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- Percy FitzPatrick Institute, University of Cape Town, Rondebosch 7701, South Africa. E-mail: peter.ryan@uct.ac.za

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